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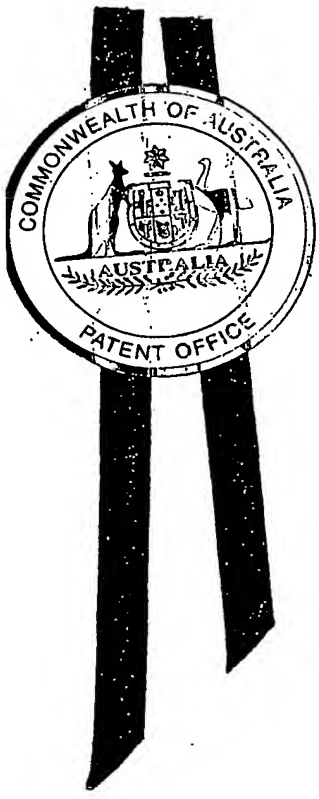
I, JULIE BILLINGSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2002950802 for a patent by PETER SKALA and JAO WU as filed on 15 August 2002.



WITNESS my hand this
Twenty-second day of August 2003

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PROVISIONAL SPECIFICATION FOR THE INVENTION ENTITLED—

FLUIDIC VORTEX AMPLIFIER

The invention is described in the following statement:-

This invention relates to apparatus for regulating fluid flow. More particularly, although not exclusively, it discloses an improved water saving shower head.

In order to conserve water it is common practice to install water saving shower heads. The devices currently used for this are quite rudimentary in operation. They typically reduce consumption by employing a small inlet to the shower head to reduce flow. The volume of water emanating from the head may also be decreased simply by using reduced diameter spray holes. While such designs are to some extent successful their effectiveness is limited because a reduction in flow rate also reduces the pressure of the spray. Consequently shower heads which operate at the current benchmark of 9 litres per minute for an AAA rating have problems with low spray pressure, restricted spray patterns and clogging of the outlet holes in the spray head. Also, for many people a shower spray of 9 litres per minute from existing devices feels inadequate.

It is therefore an object of this invention to ameliorate the aforementioned disadvantages and accordingly apparatus for regulating fluid flow through a spray nozzle is disclosed, said apparatus including a circular chamber defined by spaced apart end walls connected by a peripheral side wall, a first fluid inlet entering tangentially through said peripheral side wall, an outlet exiting through one of said end walls at or adjacent the centre axis of said circular chamber and at

least one further inlet means whereby in use of said apparatus a primary flow of fluid entering through said first inlet is constrained to follow a circular flow path which forms a vortex commencing at the internal radius of said periperal side wall and increases in velocity and pressure toward said outlet and a secondary control flow of fluid entering through said at least one further inlet means at substantially 90 degrees to said circular flow path regulates and atomises said primary flow into a spray which emanates from said outlet.

Preferably said at least one further inlet means includes an inlet positioned close to the periphery of said circular chamber.

It is further preferred that said secondary control flow follows a radial path from said inlet means to said outlet.

It is further preferred that the apparatus includes means for adjusting the secondary control flow into said circular chamber.

The currently preferred embodiments of the invention will now be described with reference to the attached drawings in which:-

figure 1 is a schematic perspective view of a first embodiment of the invention showing the

circular chamber with inlets and outlet,

figure 2 is a schematic cross-sectional view of the chamber of figure 1 along the lines X-X,

figures 3 and 4 are cross-sectional views along the centre axis of water saving shower heads constructed according to this first embodiment,

figure 5 is a cross-sectional view of a disc which is used to form the circular vortex chambers in the shower heads of figures 3 and 4,

figure 6 is a schematic perspective view of a second embodiment of the invention showing the circular chamber with inlets and outlets,

figure 7 is a schematic cross-sectional view of the chamber of figure 6 along the line X'-X',

figure 8 is a cross-sectional view along the centre axis of a shower head constructed according to this second embodiment,

figure 9 is a sectional view along the lines X1-X1 of figure 8,

figure 10 is a cross sectional view along the centre axis of an adjustable shower head constructed according to this second embodiment,

figure 11 is a sectional view along the lines X2-X2 of figure 10, and

figure 12 is a cross-sectional view along the lines X3-X3 of figure 11.

Referring first to figures 1 and 2 there is a chamber indicated generally as 1 with spaced apart end walls 2, 3 and a peripheral side wall 4. There is an inlet 5 which enters tangentially through the side wall 4 and an outlet 6 which exits through end wall 2 along the centre axis of the chamber. There is also a further inlet through end wall 3 which is shown in alternative positions 7A and 7B which are aligned with the chamber centre axis and offset toward the peripheral side wall 4 respectively.

As best shown in figure 2 a primary fluid flow 8 entering through inlet 5 is constrained to follow a circular path 9 around the inside wall 4 of the chamber. It thus forms a vortex which, if the fluid is water, increases in velocity and pressure as the vortex diameter decreases toward the centre axial outlet 6. This is shown by the following formulas:-

$V_r = V(\frac{r}{R})^n$ where V_r is the velocity of the water at the maximum internal radius of the chamber, V_r is the velocity at any smaller radius and $0 > n > -1$ for the viscosity of water

Therefore $V_r > V$

Also $dp = \rho V^2 \frac{dr}{r}$

Therefore (after definite) $P_r = P + \frac{\rho V^2}{2n}\left[\left(\frac{r}{ro}\right)^{2n} - 1\right]$

where ρ is the density of water, P is the pressure at the maximum internal radius of the chamber and P_r is the pressure at any smaller radius.

The inventor has discovered that this increase in velocity and pressure can be regulated and the water flow broken into

a fine spray at the outlet 6 by the introduction of a secondary control flow 10A or 10B through inlet 7A at the centre of the chamber or inlet 7B offset toward the side wall 4. This control flow while having a much smaller velocity and pressure nevertheless has the effect of disrupting the vortex whereby the flow rate through the outlet 6 is both reduced and atomised into a fine spray. It has also been found that relatively small and easily adjusted changes in this secondary control flow can be used to effect much larger variations in the primary flow through the chamber.

It is envisaged that the use of inlet 7A aligned with the chamber axis would produce a spray suitable for commercial and indusrial applications while inlet 7B near the periphery would be best suited for domestic showers.

Figure 3 shows an example of a shower head which according to this invention includes a circular vortex chamber 11 to receive the primary and secondary water flows (not shown). The regulated atomised spray exits through a single hole nozzle 12 fitted to the chamber outlet 13.

Figure 4 shows a similar arrangement to figure 3 with the vortex chamber 14. In this case however the secondary water flow into the vortex chamber is adjusted by the user rotating an outlet nozzle housing 15 which in turn regulates the discharge volume through the chamber outlet 16 and nozzle 17.

Figure 5 shows an internal disc 18 which is preferably used to form the aforementioned vortex chambers 11 and 15 and also distribute the primary and secondary flows into said chambers. With these embodiments both flows enter the chamber through the face 19 of the disc. The primary water flow enters tangentially through aperture 20 and the secondary flow enters through aperture 21.

With the second embodiment of the invention shown schematically in figures 6 and 7 the main components that correspond in function to those of figures 1 and 2 are identified by the same numbers which however are primed (') to distinguish them.

There is a circular vortex chamber 1' with spaced apart end walls 2' and 3' and a peripheral side wall 4'. There is an inlet 5' which enters tangentially through the side wall 4' and an outlet 6' which exits through the end wall 2' along the centre axis of the chamber. There is a further inlet pipe 22 through end wall 3' which is preferably parallel with the chamber centre axis but offset toward the peripheral side wall 4'. This inlet pipe 22 passes completely through the end wall 3' and extends well into the chamber to terminate a relatively small distance from the opposite end wall 2'.

As best shown in figure 7 a primary flow 8' entering through inlet 5' is constrained to follow a circular path 9' around the inside wall 4' of the chamber. It thus forms a vortex

which, if the fluid is water, increases in velocity and pressure as the vortex diameter decreases toward the centre axial outlet 6'. The mathematical formulas describing this are the same as for the first embodiment.

The increase in velocity and pressure can be regulated and the water flow broken into a fine spray at the outlet 6' by the introduction of a secondary control flow 23 through inlet 22. This flow 23 enters the chamber 1' adjacent the end wall 2' and follows an inward radial path (arrow 24) along said wall toward the outlet 6' which is substantially distinct from the aforementioned circular path 9' of the primary flow 8'. The radial configuration of this control flow 23 along the wall 2' has been found by the inventor to enable better control and atomisation of the primary flow 8 than the arrangement of the first embodiment described with reference to figures 1 and 2.

Figures 8 and 9 show a detailed example of a water saving shower head constructed in accordance with this second embodiment. The shower head includes a circular vortex chamber 24 to receive the primary and secondary (control) flows. The regulated atomised spray exits through a single nozzle 25 fitted to the chamber outlet 26. In this case however as shown in figure 9 the chamber forming disc 27 includes four inlet ports 28 spaced around the side wall 28A. These ports connect with water inlet conduits 29 and direct both the primary flows into the chamber through tangential

inlets 30 and the secondary (control) flows into the gap 31 between the disc 27 and the shower housing 32. The control flow after entering the gap 31 then proceeds radially inward through the chamber to the outlet 26. The spray characteristics of the shower head are determined by the fixed width of this gap 31 as it sets the magnitude of the radial control flows relative to the primary flows.

Figures 10 to 12 show another shower head in which the spray pattern can be varied by the user through adjustment of the gap width 33 between the chamber forming disc 34 and the shower head housing. Such adjustment is obtained by rotation of a portion 35 of the housing with respect to the nozzle 36. The arrangement for the inlet ports 37 to the vortex chamber 38 is similar to that of figures 8 and 9 in that a single supply of water from inlet conduit 39 is preferably split by the ports 37 into both primary tangential flows which form the vortex and radially directed control flows.

From tests conducted by the inventor the following advantages are apparent with shower heads constructed according to this invention.

- a reduced nozzle flow rate down to 2 litres per minute can be obtained at an increased constant pressure over the supply,
- the outlet nozzle flow remains constant and is self-regulating with little regard to the supply pressure to the shower head,

- the nozzle spray is finer and more uniform than that from current water saver shower heads,
- the shower spray at low flow rates feels more substantial than the spray emanating from current shower heads,
- the increased flow pressure and atomising created by the chamber vortex enables a single hole nozzle to be used which avoids problems of clogging even with hard water,
- the outlet nozzle flow and water temperature are not significantly affected by changes in supply pressure, and
- stepless adjustment of the secondary control flow into the chamber by simple rotation of a shower head valve is able to vary the nozzle discharge, reduce water usage and alter the spray pattern without disruption of water flow.

It will thus be appreciated that this invention at least in the form of the embodiment disclosed provides a novel and improved form of water saving shower head. Clearly however the examples described are only the currently preferred forms of the invention and a wide variety of modifications may be made which would be apparent to a person skilled in the art. For example the relative size of the circular chamber, the shape and configuration of the outlet nozzle, the placement, number and design of the control flow inlet ports, and the means of adjusting the control flow pressure may all be

changed to suit applications other than shower heads following further development work by the inventor. It is also envisaged that the control flow could use a separate supply and comprise a different fluid to that of the primary flow in which case the apparatus could also function as a mixer. The invention is also not limited to any particular material for constructing the shower head although a high strength plastic or a corrosion resistant metal such as stainless steel or brass is currently preferred.

Dated this 13th day of August 2002

JAO. WU And PETER SKALA
By Their Patent Attorney
MICHAEL ANDERSON-TAYLOR

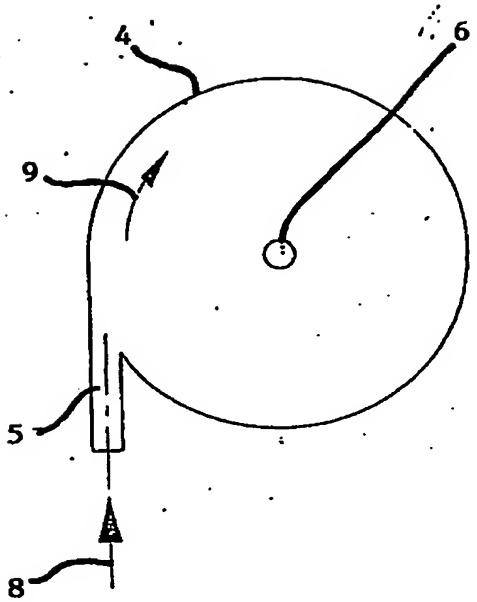

FIGURE 2

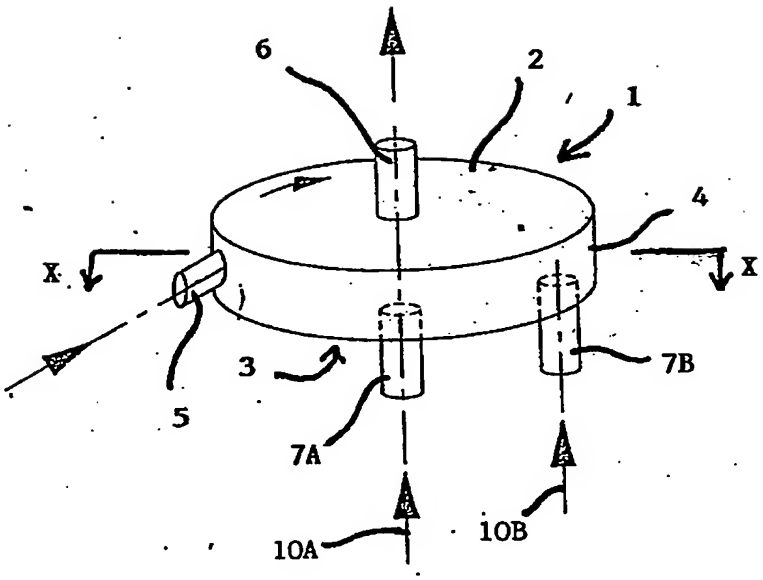

FIGURE 1

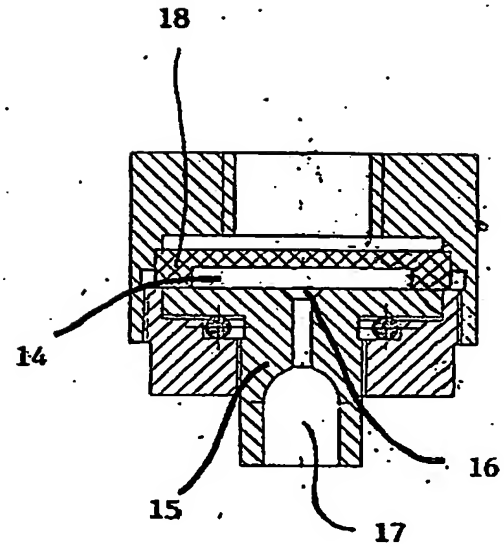

FIGURE 4

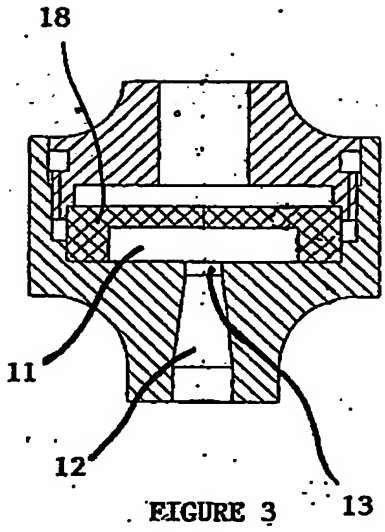

FIGURE 3

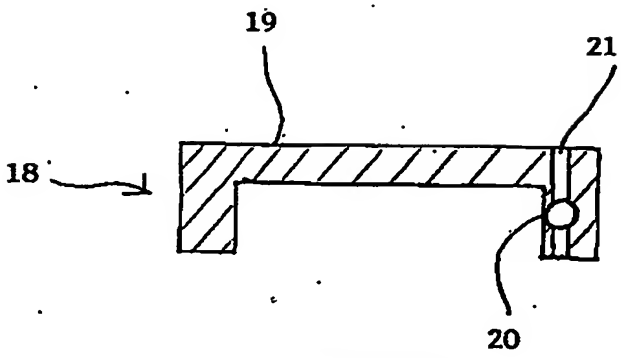

FIGURE 5

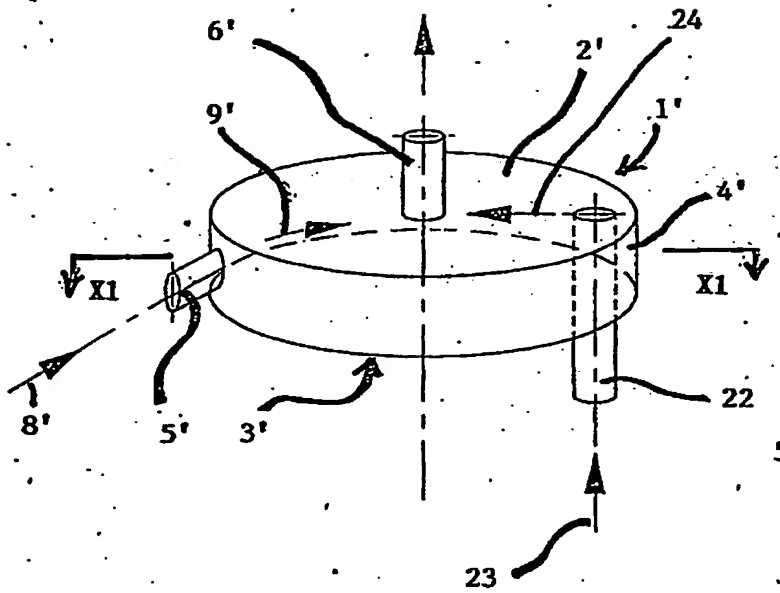

FIGURE 6

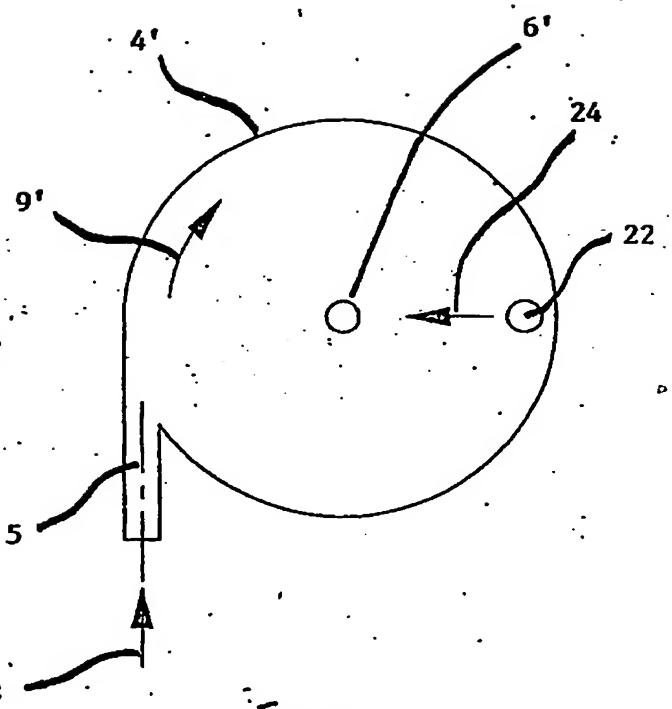

FIGURE 7

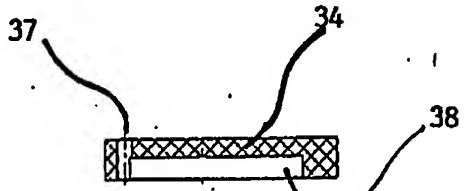

FIGURE 12

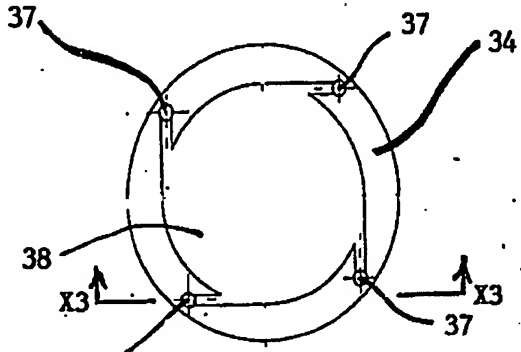

FIGURE 11

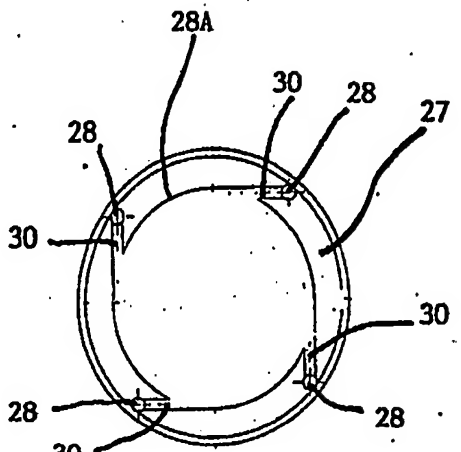

FIGURE 9

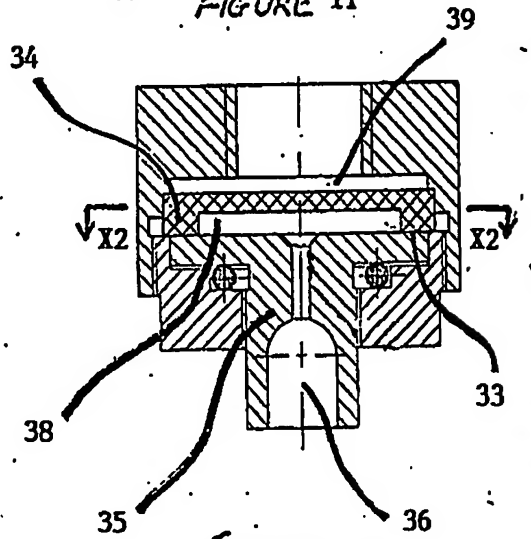

FIGURE 10

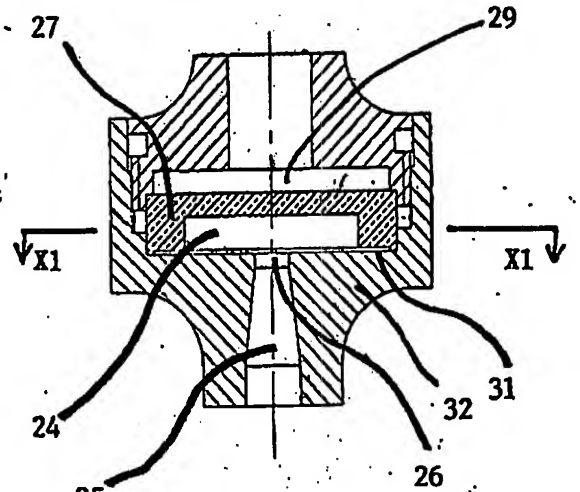

FIGURE 8